(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 123 578 B1

(12) **EUROPÄISCHE PATENTSCHRIFT**

(45) Veröffentlichungstag und Bekanntmachung des Hinweises auf die Patenterteilung:
28.08.2002 Patentblatt 2002/35

(21) Anmeldenummer: **99957932.9**

(22) Anmeldetag: **21.10.1999**

(51) Int Cl.7: **H02N 3/00**

(86) Internationale Anmeldenummer:
PCT/DE99/03389

(87) Internationale Veröffentlichungsnummer:
WO 00/025414 (04.05.2000 Gazette 2000/18)

(54) VERFAHREN ZUR ERZEUGUNG ELEKTRISCHER ENERGIE

METHOD FOR PRODUCING ELECTRICAL ENERGY

PROCEDE DE PRODUCTION D'ENERGIE ELECTRIQUE

(84) Benannte Vertragsstaaten:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

(30) Priorität: **22.10.1998 DE 19848852**

(43) Veröffentlichungstag der Anmeldung:
16.08.2001 Patentblatt 2001/33

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(56) Entgegenhaltungen:
US-A- 3 518 461
US-A- 4 206 396
US-A- 4 433 248

Printed by Jouve, 75001 PARIS (FR)

Beschreibung

[0001] Es ist ein Verfahren bekannt zur Erzeugung hoher Gleichspannungen durch mechanische Verschiebung elektrischer Ladungen. Dabei werden durch Triboelektrisierung oder durch induzierte Elektrisierung die Ladungen zwischen zwei Arbeitskörpern getrennt, wobei einer von ihnen mit einer Elektrode elektrisch verbunden ist.

[0002] Danach wird der zweite Arbeitskörper an eine andere Elektrode übertragen, an der eine Ladungsabnahme erfolgt. Das beschriebene Verfahren wird in Vorrichtungen realisiert, die als elektrostatische Generatoren bezeichnet werden (DE 23 36 487 A 1, European Patent Application 0229 843 A 1).

[0003] Es ist ein Verfahren bekannt zur Umwandlung der kinetischen Energie der Strömung eines Gases in elektrische Energie durch die Verschiebung der zerstäuberten elektrisch geladenen Flüssigkeitspartikeln anhand von Energie der Strömung dieses Träger-Gases (US 3 518 461 A).

[0004] Das gezeigte Verfahren enthält aber keine technische Lösung für die Frage, wie man diese Strömung des Träger-Gases formiert, wo man die Energie für diese Strömung her nimmt, und auf welche Weise die Sonnenenergie bzw. die Wärmeenergie in die Energie dieser Strömung umgewandelt werden könnte.

[0005] Es ist ein Verfahren bekannt zur Erzeugung elektrischer Energie durch Reibung einiger steifer dielektrischer Oberflächen aneinander, die aus verschiedenen Materialien bestehen, und das in einer Kompaktvorrichtung realisiert wird (European Patent Application 0366591 A1).

[0006] Die aufgeführten Vorrichtungen, die die bekannten Verfahren realisieren, werden durch die Möglichkeit der Erzeugung elektrischer Hochspannung (bis 15-20 MV), durch niedrigen Strom (bis 10 mA), also auch durch eine niedrige Leistung charakterisiert. Die Leistung dieser Vorrichtungen wird durch die maximal zulässige Oberflächendichte der Ladungen auf einem Förderer dem Träger der Ladung, einerseits und durch die Geschwindigkeit der mechanischen Bewegung dieses Ladungsförderers andererseits begrenzt.

[0007] Die Ladungsdichte ist ihrerseits durch die Entstehung der elektrischen Entladung an der Oberfläche begrenzt. Die Geschwindigkeit des Ladungsförderers ist durch die mechanischen Bewegungsmöglichkeiten der Systemteile begrenzt.

[0008] Den Wirkungsgrad des Systems bestimmen hauptsächlich die aerodynamischen Verluste bei der mechanischen Bewegung des Ladungsförderers und die Reibung der mechanischen Systemteile untereinander. In den existierenden Vorrichtungen beträgt diese nicht mehr als 15-20 %.

[0009] Der in den Patentansprüchen 1-6 angegebenen Erfindung liegt das Problem zugrunde, die Leistung und den Wirkungsgrad der das beschriebene Verfahren verwirklichenden Vorrichtungen zu erhöhen und die Umwandlung der Wärmeenergie in elektrische Energie zu ermöglichen.

[0010] Dieses Problem wird durch die in den Patentansprüchen 1-5 aufgeführte Merkmale gelöst.

[0011] Die mit der Erfindung erzielten Vorteile bestehen insbesondere darin, daß das angegebene Verfahren die Wärmeenergie irgendeines Erhitzers für ihre direkte Wandlung in elektrische Energie zu nutzen ermöglicht, wobei eine hohe Ausgangsleistung und ein hoher Wirkungsgrad erreicht wird.

[0012] Infolge der Eigenschaften der Wärmeröhren, reicht eine relativ kleine Temperaturdifferenz zwischen dem Erhitzer und dem Kühler, um eine hohe Stromgeschwindigkeit des gasförmigen Arbeitskörpers der Wärmeröhre, und folglich auch eine hohe kinetische Energie zu erreichen. Durch diese kinetische Energie bewirkt der genannte Strom die Triboelektrisierung der Arbeitskörper des elektrostatischen Generators und die mechanische Trennung der Ladungen.

[0013] In den dieses Verfahren realisierenden Vorrichtungen fehlen somit mechanisch bewegte Teile, dadurch werden alle deswegen entstehenden Leistungs- und Wirkungsgradverluste vermieden. Außerdem erfolgt in diesem Fall der Antrieb nicht durch äußere mechanische Arbeit, sondern durch Wärmeenergie, welche sogar aus einer kleinen Temperaturdifferenz abgenommen werden kann.

[0014] Die Ausführungsbeispiele des Verfahrens sind in den Zeichnungen dargestellt und werden im folgenden näher beschrieben.

[0015] Es zeigen:

Fig. 1
Ausführungsbeispiel des Verfahrens in einer stationären Vorrichtung mit seiner angegebenen Orientierung im Gewichtskraftfeld.

Fig. 2
Ausführungsbeispiel des Verfahrens in einer Vorrichtung, die bei verschiedenen Orientierungen, im Gewichtskraftfeld, als auch in der Schwerelosigkeit funktionieren kann.

Fig. 3
Ausführungsbeispiel des Verfahrens, bei dem die Elektrisierung der Arbeitsflüssigkeit des elektrostatischen Generators nicht am Ort ihrer Loslösung von der Mündung der Speiserdüse erfolgt, sondern in einiger Entfernung von dieser durch das Zerschlagen der Tropfen beim plötzlichen Auftreffen auf das Netz.

[0016] Alle Arten der Geräte, die den Prozeß ermöglichen, beinhalten die Wärmeröhre (WR) 1 und der Generator 2. Die Wärmeröhre 1 besitzt den Arbeitskörper in flüssiger Phase (die Arbeitsflüssigkeit der WR) 3, so wie in der Gasphase (das Arbeitsgas der WR) 4, und ein Kapillareinsatz der Wärmeröhre 5. Der Generator 2

enthält den harten Arbeitskörper des Generators 6, den flüssigen Arbeitskörper des Generators 7, das Netz für die Ladungsabnahme 8, die äußeren Elektroden 9a und 9b und die Kontur 10 für die Rückführung des flüssigen Arbeitskörpers.

[0017] Beim Aufbau eines äußeren Temperaturgradienten zwischen dem Verdampfer 11 und dem Kondensator der Wärmeröhre 12 verdampft die Arbeitsflüssigkeit der WR im Verdampfer auf seiner Kapillarstruktur. Gleichzeitig verdichtet sich das Arbeitsgas WR auf der Kapillarstruktur des Kondensators der WR. Die Flüssigkeit 3 gelangt über den Kapillareinsatz 5 aus dem Kondensator zurück in den Verdampfer.

[0018] Es genügt für den Fortgang des Prozesses, daß dem Arbeitskörper der WR die verborgene Wärme der Dampfbildung im ersten Fall zugeführt und im zweiten Fall abgeführt wird. Deshalb kann dieses Prozeß auch bei sehr kleiner Temperaturdifferenz durchgeführt werden.

[0019] Dabei vergrößert sich sprungartig das Volumen des Arbeitskörpers der WR im Verdampfer und infolgedessen auch der Druck des Arbeitsgases 4 im Verdampfer. Genauso sprunghaft verkleinert sich das Volumen des Arbeitskörpers und der Druck des Arbeitsgases der WR im Kondensator.

[0020] Damit finden bei einer kleinen Temperaturdifferenz in einem geschlossenen Raum gleichzeitig und ununterbrochen zwei, den Eigenschaften nach explosionsartige, mit verschiedenen Vorzeichen ablaufende und im Raum verteilte Prozesse der Erhöhung und Erniedrigung des Gasdrucks statt. Dies führt zur Entstehung eines Hochgeschwindigkeitsgasstroms aus dem Verdampfer in den Kondensator.

[0021] Dabei wandelt sich die Wärmeenergie, die der Wärmeröhre zugeführt wird, in die kinetische Energie der Moleküle des Gasstroms um und kann im weiteren in andere Arten von Energie umgewandelt werden, z. B. in elektrische Energie.

[0022] Der harte Arbeitskörper 6 und der flüssige Arbeitskörper 7 des Generators 2 werden im Inneren der Wärmeröhre untergebracht, etwa am Ort des maximalen Stroms des Arbeitsgases der WR 4, unmittelbar hinter dem Diaphragma 13. Das Diaphragma 13 konzentriert den Gasstrom aus dem Verdampfer in den Kondensator. Dabei ist der harte Arbeitskörper 6 bzgl. der WR unbeweglich befestigt.

[0023] Der flüssige Arbeitskörper 7 wird in das Innere der WR über den Speiser 14 zugeführt, wobei die Ladungstrennung und die Ladungsverschiebung mit Hilfe der gerichteten Gasströmung der Wärmeröhre erfolgt, welche die Flüssigkeitspartikel mitführt und ihn zur Ladungstrennung und Verschiebung an dem anderen Arbeitskörper vorbeiführt.

[0024] Im weiteren erfolgt die Ladungsabnahme auf die äußere Elektrode 9a, im ganzen analog zu dem, wie dies in den elektrostatischen Generatoren mit harten Körpern erfolgt.

[0025] Bei der Variante der Verfahrensdurchführung (Fig. 2) ist die Kontur 10 für die Rückführung des flüssigen Arbeitskörpers 7 des Generators mit der Kapillarstruktur aufgefüllt. Dies gibt die Möglichkeit, die Arbeit des Gerätes unabhängig von dessen Lage im Feld der Gewichtskräfte, und auch in der Schwerelosigkeit, durchzuführen. Dabei ist die offene Oberfläche der erwähnten Kapillarstruktur unmittelbar hinter dem Netz der Abnahmeelektrode 8 untergebracht.

[0026] Bei den Ausführungsbeispielen anderer Varianten des Verfahrens (Fig. 3) erfolgt die Ladungstrennung durch das Auftreffen der Flüssigkeit 7 auf den Körper 6. Dabei hat der Körper 6 die Form von z. B. einem Netz. In diesem Fall wird der harte Arbeitskörper in einiger Entfernung /von dem Einführungsort des Speisers 14 ins Innere der Wärmeröhre gebracht. Die Tropfen des Körpers 7 gewinnen noch vor dem Aufprall auf dem Körper 6 eine gewisse kinetische Energie, die für die Ladungstrennung geleistet wird. Nach dem Aufprall werden die geladenen Tropfen weiter mit dem Gasstrom der WR 4 zur Elektrode 8 fortgetragen.

[0027] Die nicht kondensierenden Gase, die in der Wärmeröhre verweilen (z. B. Luft, und auch Dämpfe der Arbeitsflüssigkeit des Generators, die unvermeidlich in einem geschlossenen Raum mit der Flüssigkeit, die eine freie Oberfläche hat, vorhanden sind), werden in den ersten Sekunden der Arbeit von der WR durch das Arbeitsgas der WR zu einem der Röhrenenden abgedrängt, und bilden ein Gaskissen 15.

[0028] Bei der Geometrie der WR und der Elektrode für die Ladungsabnahme 8 (Abb. 1-3), isoliert dieses Gaskissen gewissermaßen thermisch die Abnahmeelektrode 8 und die ihr anliegende Wand der Wärmeröhre. Deshalb unterscheidet sich die Temperatur der Elektrode in allgemeinem Fall von der Temperatur der Kapillarstruktur des Kondensators der Wärmeröhre.

[0029] Da der Einführungsort des Speisers 14 in die WR sich außerhalb des Verdampfers befindet, kann als die Arbeitsflüssigkeit der WR und des Generators eine und die selbe Flüssigkeit verwendet werden.

Patentansprüche

1. Verfahren zur Erzeugung elektrischer Energie, bei dem Ladungen zwischen zwei Arbeitskörpern triboelektrisch oder elektrostatisch getrennt, die Ladungen durch Verschiebung von Arbeitskörpern unter Einwirkung äußerer Kräfte voneinander entfernt werden, wobei die äußeren Kräfte gegen die Coulomb Kraft Arbeit leisten, und die Ladungen auf Elektroden geführt werden,
dadurch gekennzeichnet
duß die genannten Verfahrensschritte innerhalb des Innenvolumens einer Wärmöhre **(1)** durchgeführt werden, wobei die Ladungstrennung und die Ladungsverschiebung mit Hilfe der gerichteten Gasströmung der Wärmeröhre erfolgt, welche den einen Arbeitskörper **(7)** mitführt und ihn zur La-

dungstrennung und Verschiebung an dem anderen Arbeitskörper **(6)** vorbeiführt.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, daß** der eine Arbeitskörper in der Gasströmung mitgeführte Flüssigkeitspartikel umfasst.

3. Verfahren nach Anspruch 1 oder 2, **dadurch gekennzeichnet, daß** der eine Arbeitskörper **(7)** ein von der Gasströmung durchströmtes Netz umfasst.

4. Verfahren nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, daß** der andere Arbeitskörper **(6)** innerhalb der Wärmeröhre (1) etwa an der Position maximaler Strömungsgeschwindigkeit angeordnet ist.

5. Verfahren nach einem der Ansprüche 2 bis 4, **dadurch gekennzeichnet, daß** die Flüssigkeit zur Bildung der Flüssigkeitspartikel rückgewonnen wird.

6. Verfahren nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, daß** als die Arbeitsflüssigkeit **(3)** der Wärmeröhre **(1)** und des Generators **(2)** ein und dieselbe Flüssigkeit verwendet wird.

Claims

1. Process for producing electrical energy, in which the charges between two working media are separated triboelectrically or electrostatically, the charges are moved away from one another by displacement of the working media under the action of external forces, the external forces performing work against the Coulomb force, and the charges being guided onto electrodes,
wherein
the indicated process steps are carried out within the inside volume of a heat pipe **(1)**, charge separation and charge displacement taking place using the directed gas flow of the heat pipe, which flow entrains one working medium **(7)** and routes it past the other working medium **(6)** for charge separation and displacement.

2. Process as claimed in claim 1, **wherein** one working medium encompasses liquid particles which are entrained in the gas flow.

3. Process as claimed in claim 1 or 2, **wherein** one of the working mediums comprises a grid through which the gas flow passes.

4. Process as claimed in one of claims 1 to 3, **wherein** the other working medium (6) is located within the heat pipe **(1)** roughly at the position of maximum flow velocity.

5. Process as claimed in one of claims 2 to 4, **where** the liquid is recovered to form the liquid particles.

6. Process as claimed in one of claims 1 to 5, **wherein** the same liquid is used for the working liquid **(3)** of the heat pipe **(1)** and of the generator **(2)**.

Revendications

1. Procédé de production d'énergie électrique par séparation des charges sur deux corps actifs par la méthode triboelélectrique ou électrostatique. Ces charges sont séparées l'une de l'autre par le déplacement des deux corps actifs par l'impression de forces extérieures, qui par l'action contre la force Coulombienne fournissent un travail. Il en résulte le transport des charges sur les électrodes.
Ce procédé est **caractérisé par le fait que** les actions successives ont lieu dans un volume interne d'un tube de chaleur (HEAT PIPE) (1), ces actions de séparation de charges et le transport de charges étant accomplis par flux forcé d'un gaz, qui entraîne un des corps actives (7) et le font passer sur l'autre corps actif (6) pour établir la séparation et le transport des charges.

2. Procédé suivant le droit 1, étant **caractérisé par** le corps actif entraîné par le flux de gaz, est constitué par des particules liquides.

3. Procédé suivant le droit 1 ou 2, étant **caractérisé par** un corps actif (7), qui est réalisé par un grille traversée par le flux gazeux.

4. Procédé suivant les droits 1 à 3, étant **caractérisé par** l'autre corps actif (6) placé à l'endroit du maximum de vitesse de gaz à l'intérieur du tube de chaleur (HEAT PIPE) (1).

5. Procédé suivant les droits 2 à 4, étant **caractérisé par** le recyclage du liquide, à partir duquel les particules liquides sont formée.

6. Procédé suivant les droits 1 à 5, étant **caractérisé par** le même liquide, qui sert à la fois de liquide actif (3) dans le tube de chaleur (HEAT PIPE) (1) et dans le générateur (2).

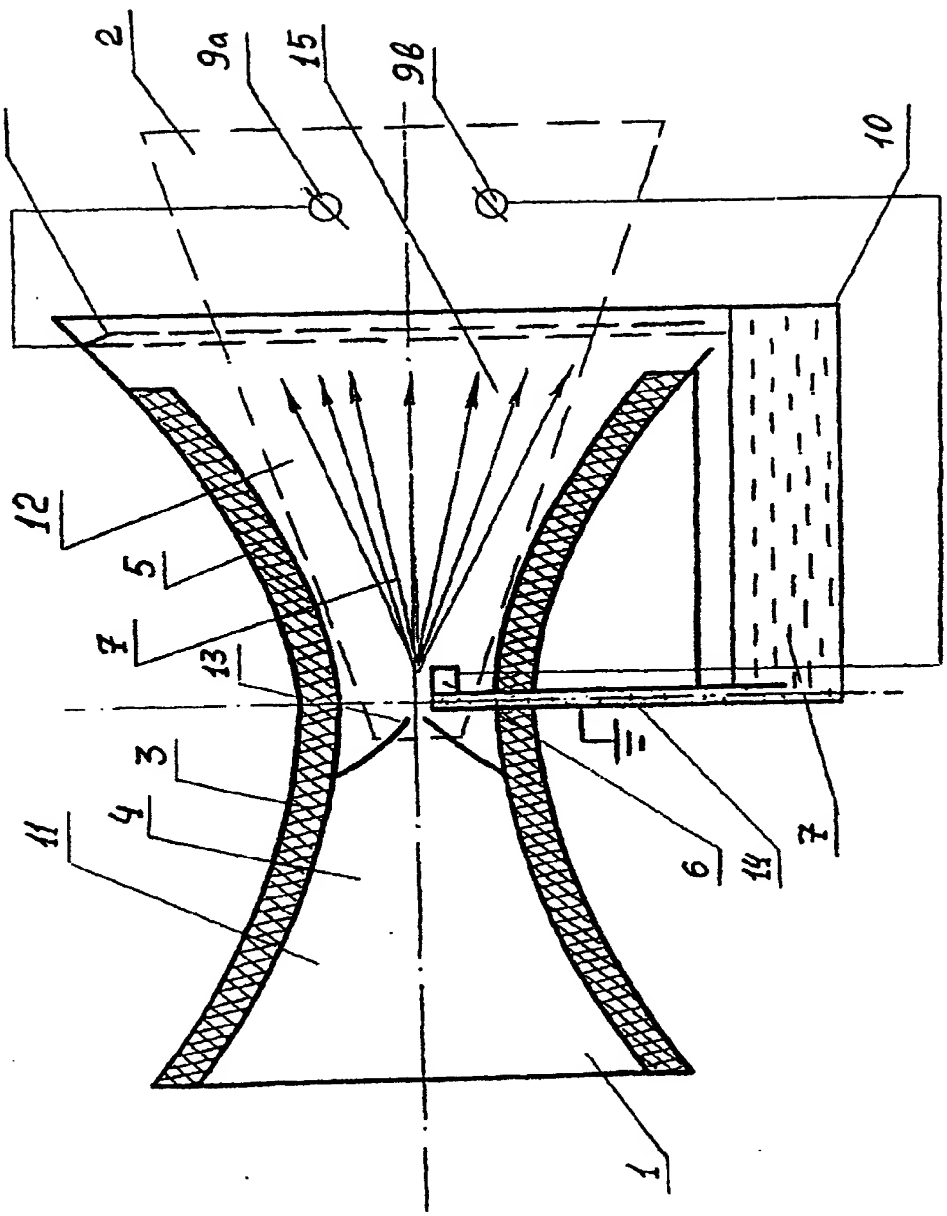

Fig. 1.

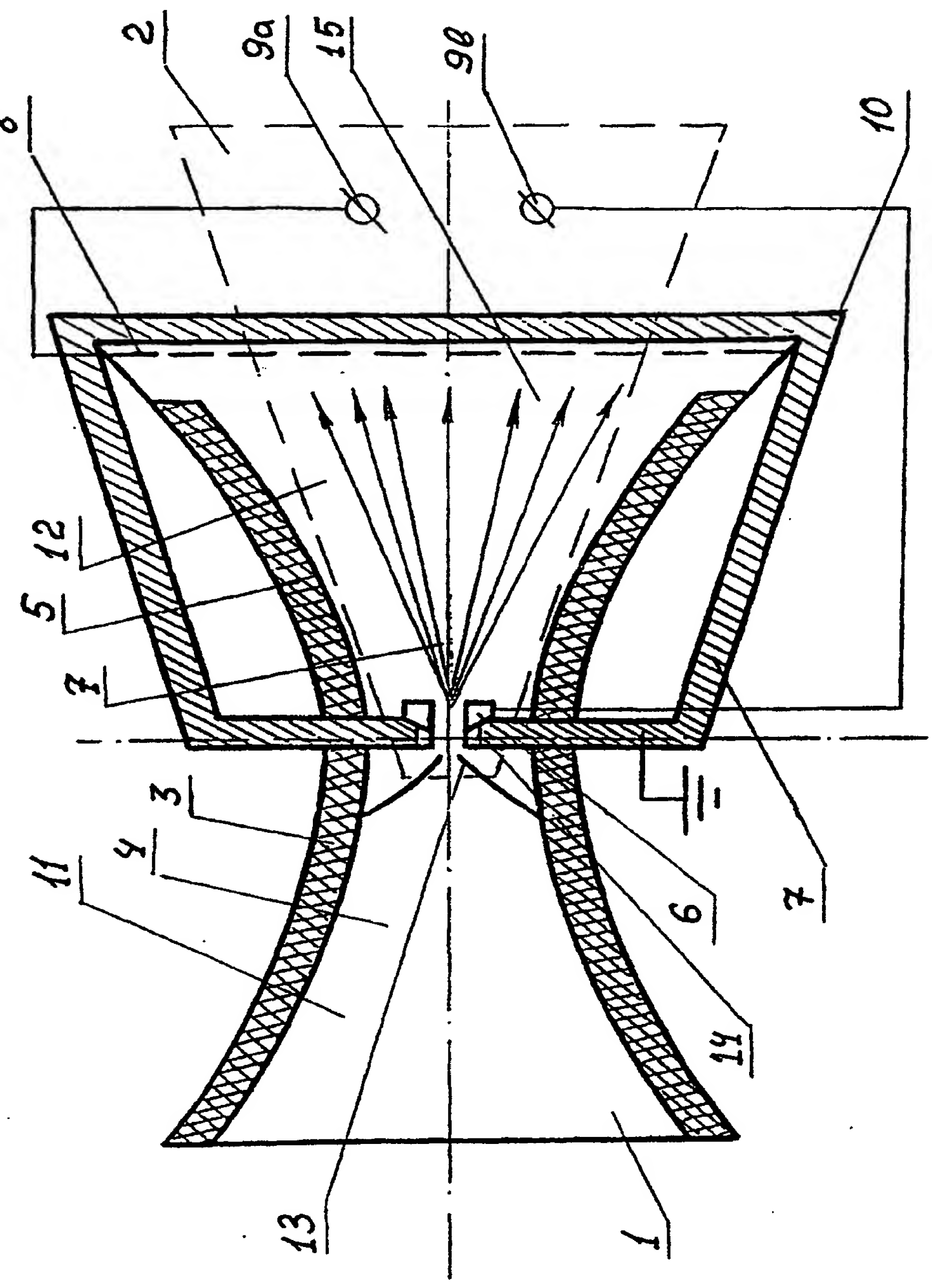

Fig. 2

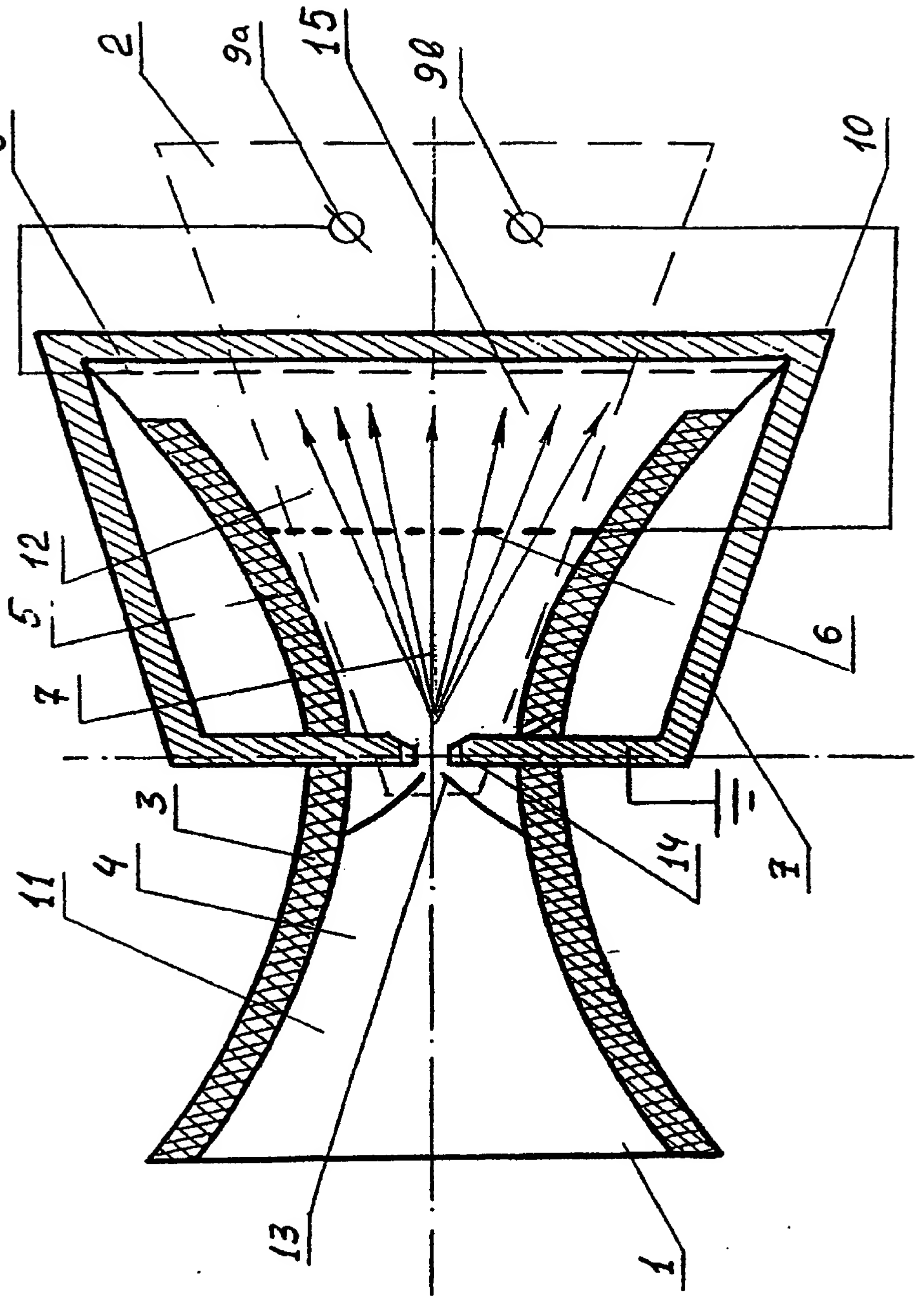

Fig. 3.

To:
Mr. Nicholas Ponomarenko,
Primary Examiner
Technology Center 2800
United States Patent and Trademark Office
Washington, DC, 20231

Concern: Non-Final Decision for Application Number 09/830,017
Title: Method for producing electrical energy
Inventors/applicants: Dr. A. Luchinskiy, Prof. Dr. G.Werth, Prof. Dr. Y. Shifrin
Amended Title: **ELECTROGASDYNAMIC METHOD FOR GENERATION ELECTRICAL ENERGY**
PCT /DE 99/03389
US filing date 07/27/2001

Dear Mr. Ponomarenko,

Thank you very much for your examination.

According to your requirements the following amendments were done:

AMENDMENTS :

Amendment 1):
The main amendment is a correction of the principle language translation error:

German term "**Wärmerohr**" was wrong translated as "heat tube", which word-combination has not technical meaning. And as a result the technical sense of the description was lost at all. Because the term "Wärmerohr"(engl.: "heat pipe", rus.: "тепловая труба") has the absolutely definite and the same in all countries technical meaning, which determines the sense of description of our invention and lays in the grounds of the claims.

As a proof, that the question in point is a language error by the translation of this technical term, and therefore no new matter was introduced by this amendment (term correction), the following papers are enclosed:

1) Articles from one general encyclopaedia **(Enclosure 1)**, and from one special technical encyclopaedia **(Enclosure 2)**, where the term "Wärmerohr" ("heat pipe") is completely determined, and near the German term it's English translation is showed in brackets.

2) Copy of article from a Russian-edited translation from the US reference book with the same translation and meaning of this term (heat pipe = тепловая труба = Wärmerohr), which also proofs the international uniformity of this term and it's meaning. (**Enclosure 3**).

3) Our European patent for this invention **(Enclosure 4)**, which contains both German and English terms.

By making this correction the following misunderstandings by reading of the invention's description (not-amended text) should be removed:

1) Because the term "heat pipe" is completely determined both in general encyclopaedias and in special reference books (s. Enclosures 1-3), and this term has the definite and the same in all countries technical meaning, we have not quoted the complete explanation description of the meaning of this term in the description of our invention.

In particular such properties as **effective workingability already by low temperature differences**, and the possibility to obtain **a high velocity gas stream** were explained in our previous (not amended) description with the reference on the term "heat pipe", without a detailed explanation how a heat pipe works.

In the amended description we are inserting the reference to one US reference book with it's description (s. above-mentioned Enclosure 3).
Except we are inserting into the amended description the short principal explanation (in "Brief Summary"-section) and detailed explanation (in Detailed Description"- section) of the main physical and technical principles of work of the heat pipes.

Namely:
the fact that evaporation and condensation on capillary structures run very intensively in comparison with these processes on a liquid's free surfaces;
the fact that these two phasetransfer processes, which are proceed with different signs, and are explosive/implosive-like (e.g. characterized by sharp increase and decrease of the volume of the working medium) by its features, take place simultaneously and uninterruptedly in a closed space and in immediate proximity of each other. This leads to formation of a high speed gas flow from the vaporizer into the condenser. And it takes place already by low temperature difference;
etc.

Thus, the first and the main amendment is replacing of words "**heat tube**" with the term "**heat pipe**".

Amendment 2):
In **Claim 1** the word "**here**" (Germ. "**wobei**", s. Germ.-langu. WIPO publication and European patent) was loss by translator in the English translation. We are restoring this word, but it does not important.

(Therewith the phrase: "*... the external forces performing work against the Coulomb force;...*" is replaced with the phrase "*...**here** the external forces performing work against the Coulomb force;...*)

Amendment 3):
We are wording the **Claim 2** more exactly and therefore more narrow particular in comparison to the WIPO-PCT publication and to the European patent. By doing so the claimed by Claim 2 matter is formally reduced in comparison to WIPO publication and

European patent, but the content of description becomes more understandable. We do not see a problem in this patented matter reducing, because the combination of all claims covered everything we need anyway.
The fact, that heat pipe in our case has a necked down section in it's transport zone, and generator's liquid working medium is entrained in this narrow, is supported both by the patent description's not-amended text (in several places) and by all of 3 Figures.

Amendment 4):
Title of invention was amended according to the requirement, named in the decision.

Other amendments due to your requirements are shown below in the table.

ABOUT THE EXISTING SOLUTIONS :

The US- 5.185.541, US-3.651.354, US- 3.638.054; US-3.612.923; US- 3.582.694; US-3.225.225, indicated in the "Notice of References Cited" from your Decision, as well also US 3 518 461 A, etc. from the PCT International Search Report can not be opposed to our invention, because all of them describes the different constructions of a liquid-drops electrostatic generator, which working media are charged liquid drops, and the source of energy is a mechanical energy of some kind of stream of carrier gas. (And besides it does not matter, wherefrom this stream of carrier gas takes it's mechanical energy).

No of these inventions give a technical solution for the problems how to create the high speed flow of this carrier gas, where the energy for this gas flow can be taken from, and how to convert the sun energy or the heat energy already by low temperature differences into this high speed gas flow energy.

And in our invention we are using the Heat Pipe principle for the creation of a high speed carrier gas for the gasdynamic electrostatic generator, and we are executing the "...charges separation, displacement and there guiding onto electrodes, etc...", that is the electrostatic generation, by the energy of this gas stream. And it is the matter of our invention.

(With other words the electrostatic generator's liquid 7 is supplied into the interior of a heat pipe, concretely into it's transport zone, charge separation and the further charge displacement, as well there guiding onto electrodes are carried out by the gas stream of this heat pipe, which stream flows through this transport zone with a big speed.)

Our solution gives the possibility to use effectively the sun energy as an energy source for the liquid-drops electrostatic generators. And it also gives the possibility to use the heat energy as an energy source for the liquid-drops electrostatic generators already by low temperature differences. Because heat pipe gives the possibility to convert these above mentioned kinds of energies into the energy of it's own **high speed gas stream** very effective (no other known methods can be used so effective for the creating of high speed gas stream by the energy from the a.m sources); and therefore the further operation step: drive of electrostatic generator with this gas stream is very effective.

It is necessary to note, that nobody from the authors of the above-mentioned generators, had not given a solution, how **to create** a high velocity gas stream for there generators by using of

sun energy or of heat energy already by low temperature differences. Authors of the US 3 518 461 A (s. PCT International Search Report) in there later solutions (4 433 248 A, US 4 206 396 A) had to use an energy of wind for this purpose. (By the way, they are citing US 3.225.225 in there invention, but nevertheless had to use wind. Because US 3.225.225 (electrostatic generator with heat source) do not give solution for low temperature differences and therefore for renewable heat energy sources).

Respectfully,

Alexander Luchinskiy

Next sheets : 1) Table of amendments; 2) Not-amended details.

Content of amendment	**Proof that no new matter was introduced by this amendment**
CLAIMS : (detailed s. above in the covering letter)	1) The translation's language errors were corrected (the most important main amendment); 2) Claim 2 was reworded more exact (explanation why no new matter was therewith inserted, is given above in the covering letter.
DROWINGS :	
1. Orientation in the gravitational field for the Fig. 1 is showed. (Requirement from page 2 of the Not-final decision) $\downarrow \overline{mg}$	In the Fig.1 was assumed, that the vertical direction in the picture is vertical in reality, i.e. the same with the direction of the gravitational field. Except the surface of liquid 7 is horizontal in the picture, and it proves, that no any other directions could not be assumed as a direction of gravitational field.
DESCRIPTION :	
The **format** of the description was changed. (The description was rewritten in the **US patent format** instead of German patent format)	The original description of the invention was written in German format, exactly due to the German patent office requirements. Both WIPO and European patent office accept this format, therefore WIPO publication and the European patent were published in German format too. The amended text is rewritten in USPTO format, and more exact, according to requirements, which were explained in the expertise decision. The amended description either explains more detailed the already known matter from cited sources, or presents the already described before matter in the US patent format. Therefore no new matter was inserted.

LIST OF PAPERS :

1) **Covering letter**; with
2) Table of amendments;
3) Not amended details.

Enclosures to covering letter
(cites from different sources, which contain both German term "Wärmeröhr" and it's English translation "Heat Pipe" as a proof, that these terms are identical) :

4) Enclosure 1. – cite from general encyclopaedia
5) Enclosure 2. – special technical encyclopaedia
6) Enclosure 3. – reference book
7) Enclosure 4. – our European patent for this invention, which contains claims in both of languages.

Text of invention:

8) Abstract;
9) Amended application.

NOT-AMENDED DETAILES:

1) Capillary structure in the drawings.

In fact the capillary structure of the heat pipe **was showed in the drawings as a shaded cross-section 5**.

(By the way, the fact, that the loop 10 also is filled with a capillary structure (for the generator liquid transport in cases Fig. 2 and Fig 3), was indicated in the not-amended description too. Thus, all shaded cross-sections in the drawings showed capillary structures, but not walls, and it was supported with the text before it's amending).

2) Phrase " or the like" in the claim 1.

This phrase never existed neither in German-language's PCT publication and German priority document, nor in English- translated claims in the European patent publication. Obviously the case in point is a translation's misunderstanding in the US application.

2) Source for generator's liquid.

There is no source for generator's liquid 7, because this liquid is contained and circulated in the loop 10.

In the our method realisation's examples this liquid is entrained into the gas flow as in a usual pulverizer (spryer), that is due to Bernoulli effect. We think it could be wrong to explain it in the description of invention more detailed, because such method of liquid entraining is widely known; and it is also used very widely (as f.e. for perfume sprayers, paint sprayers, etc.). Therefore everything is obvious from the drawings. And on the other hand it is unrelated to the claimed matter of our invention, because the way for generator liquid entraining is not important for this claimed matter.

In our description we had not a purpose to develop the new constructions of electrostatic generators unrelated to it's energy source. We have described several simplest general examples of such kind of generators to illustrate how works our method. In one of them electrical charges are created by friction of generator's liquid 7 and solid working medium 6; in the other of them electrical charges are created by the liquid 7 striking the medium 6.
But in all of them the generator's liquid 7 is supplied into the interior of a heat pipe, concretely into it's transport zone, charge separation and the further charge displacement, as well there guiding onto electrodes are carried out by the gas stream of this heat pipe, which stream flows through this transport zone with a big speed.

ABSTRACT

A method for producing eiectrical energy in which charges are separated between two working media triboelectrically or electrostatically, the charges are moved away from one another by displacement of the working media under the action of external forces, here the external forces perform work against the Coulomb force, and the charges are routed onto electrodes, the indicated process steps being carried out within the inside volume of a heat pipe, charge separation and charge displacement taking place using the directed gas flow of the heat pipe, which flow entrains one working medium and routes it past the other working medium for charge separation and displacement. Application - use of solar energy

ELECTROGASDYNAMIC METHOD FOR GENERATION ELECTRICAL ENERGY

BACKGROUND OF THE INVENTION

This invention relates to electrogasdynamic methods of energy conversion by electrostatic principle of the electrical energy generation.

Electrostatic principle of the energy generation, as distinct from the Faraday generation principle, do not assume a mechanical displacement of an electrical conductor in a magnet field under the action of external forces and therefore the electrical charges separation due to electromagnetic induction phenomenon; but it assumes an immediate charges separation and there moving away from one another together with the charges carrier media under the action of external forces. As external forces here act the mechanical forces, which are exerted on the charges carrier media from the side of the energy source medium. As a charge carrier medium acts a dielectric conveyor band, a disk, or any other dielectric surface in the case of the solid medium's electrostatic generators, and dispersed liquid particles in the case of gasdynamic electrostatic generators.
As an energy source medium acts a mechanical drive in the case of the solid medium's electrostatic generators, and a gas flow in the case of gasdynamic electrostatic generators.

As the general characteristics, which are defining the electrostatic method of the electrical energy generation, can be named the following steps:

the charges between two working media are separated triboelectrically or electrostatically, the charges are moved away from one another by displacement of the working media under the action of external forces, here the external forces performing work against the Coulomb force; and the charges being guided onto electrodes.

As typical examples of solid medium's electrostatic generators can be cited DE 23 36 487 A 1 or EPA 0229 843 A 1, where the generating of high DC voltages by mechanical displacement of electrical charges takes place. In doing so the charges between two working media are separated by triboelectrification or by induced electrization, one of the two media being electrically connected to an electrode. Accordingly the second working medium is transferred to another electrode on which the charge is picked up.

As an example of an accomplishment of electrostatic generation in a compact solid medium's device can be cited EPA 0366591 Al. Here the producing of electrical energy by friction of certain stiff dielectric surfaces consisting of different materials against one another takes place.

The solid medium's electrostatic generators are characterized by the possibility of generating electrical high voltage (up to 15-20 MV), by a low current (up to 10 mA), therefore also by low output power. The power of these devices is limited on the one hand by the maximum allowable surface density of charges on the surface of a charge carrier medium (disk, conveyor band), and on the other hand, by the speed of mechanical movement of this charge carrier medium.

The charge density for its part is limited by the formation of an electrical discharge on the surface. The increasing of the general surface area of the charge carrier medium is impossible because this medium is a solid body with the definite geometry. The speed of the charge conveyor is limited by the mechanical motion possibilities of the system parts.

The efficiency of the system is determined mainly by the aerodynamic losses as the charge conveyor is moved mechanically and by the friction of the mechanical system parts among one another. In existing devices this is not greater than 15-20%.

The above-mentioned efficiency limitations for the electrostatic generators are eliminated in the gasdynamic variants of there constructions, which constructions uses the dispersed liquid particles as a charge carrier medium.

The total area of the dispersed particles surfaces in one selected volume is very large in comparison with the area of any surface of section through this volume. Therefore the dispersed liquid charge carrier contains and guides onto electrodes much more large total electrical charge in a unit of time, than a disk or band of the solid medium's generator. Therefore, and also owing to higher speed of the charge carrier, the above mentioned limitation for output power is eliminated.
The speed of this liquid charge carrier is not limited by the mechanical motion possibilities of the system parts, because gasdynamic generator do not contains such mechanically moving construction parts.
Because of the absence of named mechanically moving parts all other losses of power and efficiency which occur for this reason are also prevented.

The above indicated removal of limitations on the output power and efficiency of the electrogasdynamic liquid-drop versions of the constructions of the electrostatic generators (in comparison with the solid-medium ones) allows their effective use in cases when it is necessary to directly convert energy of a gas flow into the electrical energy.

Electrogasdynamic generators with electrostatic generation principle as a more effective alternative to the usual Faraday generators in the cases, when high speed gas flow energy should be converted in the electrical energy, are well known, and they are developed technically very detailed.

The physical foundations of this generation method are developed detailed theoretically and experimentally (US 3 518 461 A). Therefore on the one hand they provide the basis for the construction of different devices with different output parameters for every concrete practical purposes as required by the using equipment, and on the other hand they provide the possibility to optimize there working parameters and therewith to achieve a high efficiency of the converting kinetic energy of a gas flow into the electrical energy by displacement of pulverised electrically charged liquid particles with the energy of this carrier gas (US-5.185.541, US-3.651.354, US- 3.612.923; US- 3.582.694; US- 3.225.225). In particular also an alternating current conversion device is known, which device gives the possibility to convert the energy of gas flow into the electrical energy of alternating current by the electrostatic principle of generation (US 3 638 054).

The common shortcoming of all above mentioned methods is that the described methods do not give the technical solution for the problems how to create the high speed flow of this carrier gas, where the energy for this gas flow can be taken from, and how to convert the sun

energy or the thermal energy already by low temperature differences into this high speed gas flow energy.

The methods as usual heating of gas or vapour for the converting of thermal energy into the energy of gas flow (as it takes place for example in US 3.225.225), require heat sources with the high local concentration of thermal energy around the working space. Otherwise the high speed gas flow, which is necessary for the gasdynamic electrostatic generator can not be obtained. But on the other hand, the sun, the industrial heat wastes, as well as other renewable thermal energy sources are normally characterized by not high local energy concentrations and in most cases by low temperature differences between the energy source and the environment.

Therefore the described gasdynamic electrostatic methods and devices can not be used at all or can not be used directly for the effective converting of sun energy, or thermal energy from industrial heat wastes, or energy from other sources with low local concentrations of thermal energy.

SUMMARY OF THE INVENTION

To create an effective electrogasdynamic method for conversion of solar and thermal energy into the electrical one, it is necessary to find a way to create a high-speed carrier gas flow for the electrogasdynamic generation, already at low temperature differences. Naturally, at high temperature differences the intensity of the process will be higher.

Furthermore, if the sun radiation acts as an energy source, it is necessary that the solar energy supplied to the converter would be converted into kinetic energy of gas flow in the shortest possible time, in the ideal - instantly. Otherwise first it will be re-emitted, and also returned by other ways (as convection or heat conduction) back, which will reduce efficiency of converter, and secondly it will be converted less per unit time, resulting in power reduction of the converter.

This can be made possible by achieving a process of electrostatic generation inside the heat pipe, in its transport zone, using a flow of its working medium in a gas phase which is streaming through the transport zone, as carrier gas for the gasdynamic electrostatic generator. One of the basic properties of heat pipe is the high effectiveness of its work at small temperature differences. Design and the properties of the heat pipes are explained in detail, for example, in the (Cheeseholm, Heat Pipes, in: Heat Exchanger Design Handbook, 1983, Hemisphere Publishing Corporation).

Simultaneously two opposite processes take place in the heat pipe already at a small temperature difference: the evaporation of a liquid on capillary structure in the vaporizer and its condensation on the capillary structure in the condenser. These evaporation and condensation on capillary structures runs very intensively in comparison with these processes on a liquid's free surfaces. Boiling point of the working medium of the heat pipe can vary very strongly in different heat pipes and is selected depending on the actual temperature differences, at which it is working. The processes of evaporation and condensation on the capillary structure run intensively already at temperatures substantially lower than boiling point. These two phasetransfer processes, which are proceed with different signs, and are explosive/implosive-like (e.g. characterized by sharp increase and decrease of the volume of the working medium) by its features, take place simultaneously and uninterruptedly in a

closed space and in immediate proximity of each other. This leads to formation of a high speed gas flow from the vaporizer into the condenser.
Nowadays heat pipes are usually used only to transfer thermal energy by distance; therefore, high speed of the gas in the transport-zone of the existing devices is an undesirable side-effect, it leads to energy loss in the transport- zone because of friction, turbulence and acoustic effects. Therefore, the working medium, capillary structure, temperature difference and other parameters of the heat pipe are usually selected to reduce speed of the above mentioned flow as much as possible. For the same reason the value of permissible temperature difference is bounded from above, for high temperature difference can lead to the formation of a too rapid gas flow, and as a consequence, to great energy losses in the transport-zone.
In our case situation is opposite, though. The energy lost by the transport zone is basically the useful output energy. Therefore the speed of gas flow in that place, where it performs the role of carrier gas of the electrogasdynamic generator, must be as high as possible. For that reason, instead of the usual measures for reduction of the speed of the flow, this method assumes its increase. In particular, the heat pipe transport zone has a necked-down section, that is it has a contraction or is partitioned by a diaphragm. Thus, this way the gas stream is formed, which flows through the aperture in the diaphragm at a high speed from the vaporizer into the condenser.

The working liquid of electrostatic generator is supplied into the gas flow formed as described above. Next, using the energy of this flow one pulverizes the liquid, charges it and transports the charged drops to the electrodes.

In doing so, the charges between two working media are separated triboelectrically or electrostatically, the charges are moved away from one another by displacement of the working media under the action of external forces, here the external forces performing work against the Coulomb force; and the charges being guided onto electrodes. As external forces here act the mechanical forces, which are exerted on the charges carrier media (liquid particles) from the side of the carrier gas. The supplied energy expenditure for for charge separation and there delivery to electrodes is the output useful energy of the converter. And this energy per unit time is the output electrical power of the converter.

Solar or thermal energy, which is brought to the heat pipe's vaporizer by any common for heat pipes means, is converted very rapidly into gas flow energy of the heat pipe. This occurs because of the immediate phase transition of the working medium in the heat pipe's vaporizer without a substantial change in its temperature; thus reverse heat exchange, i.e. re-emission, or heat transmission in another manner practically does not manage to happen.

This sharply rapid energy absorption ensures a) high efficiency of the process, as the energy supplied by a source to the converter practically does not return to this source conversely, and b) high power (**E/t**) of the converter, since the time **t** by which the supplied energy **E** is transformed by this converter is small.

Thus, the proposed method does permit conversion of thermal energy into the electrical one already at small temperature differences, which makes it possible to use it for the conversion of energy from the sources with relatively low specific density of energy, such as solar energy or industrial heat wastes. Moreover, when using the traditional heat sources, which ensure large temperature differences (e.g. combustion of fuel), the efficiency of the proposed method exceeds efficiency of known methods by the above indicated reasons.

BRIEF DESCRIBTION OF THE DRAWINGS

The examples of the embodiments of this method are shown in the drawings.

Figure 1 shows an embodiment of the process in a fixed device with its indicated orientation in the gravitational field.

Figure 2 shows an embodiment of the process in a device which can function at different orientations, in a gravitational field, and also in weightlessness.

Figure 3 shows an embodiment of the process in which the working liquid of the electrostatic generator is not electrified at the site of its detachment from the mouth of the feeder nozzle, but at some distance from it by the breakdown of the droplets when they suddenly encounter the grid.

DETAILED DESCRIPTION OF THE INVENTION'S EMBODIMENTS

All types of devices which enable the method contain a heat pipe 1 and a generator 2. The heat pipe 1 has the working medium in the liquid phase (the working liquid of the heat pipe) 3 and in the gaseous phase (the working gas of the heat pipe) 4, and a capillary insert 5 of the heat pipe. The generator 2 contains the solid working medium of the generator 6, the liquid working medium of the generator 7, the grid for charge pick-up 8, the external electrodes 9a and 9b and the loop 10 for return of the liquid working medium.

When an external temperature gradient builds up between the vaporizer 11 and the condenser of the heat pipe 12 the working liquid of the heat pipe vaporizes in the vaporizer on its capillary structure. At the same time the working gas of the heat pipe condenses on the capillary structure of the condenser of the heat pipe. The liquid 3 travels via the capillary insert 5 out of the condenser back into the vaporizer.

It is sufficient for the continuation of the process that the latent heat of vaporization in the former case is supplied to the working medium of the heat pipe and in the latter case is removed. Therefore this process can also be carried out at a very small temperature difference.
Here the volume of the working medium of the heat pipe in the vaporizer increases suddenly and as a result the pressure of the working gas 4 in the vaporizer does likewise. The volume of the working medium and the pressure of the working gas of the heat pipe in the condenser decrease equally suddenly.
Thus, at a small temperature difference two processes of increase and decrease of the gas pressure take place simultaneously and uninterruptedly in a closed space; these processes are distributed in space, proceed with different signs, and are explosive/implosive-like according to properties. This leads to formation of a high speed gas flow from the vaporizer into the condenser.

In doing so the thermal energy which is supplied to the heat pipe is converted into kinetic energy of the molecules of the gas flow and can be converted further into other types of energy, in particular into electrical energy.

As a next step, obtained this way mechanical energy of the gas flow converts into the electrical energy due to the electrostatic principle of generation, i.e. the charges between two working media are separated triboelectrically or electrostatically, the charges are moved away from one another by displacement of the working media under the action of external forces, the external forces performing work against the Coulomb force, and the charges being guided onto electrodes. The above mentioned process steps are carried out within the inside volume of a heat pipe, in it's transport zone, in the gas flow of this heat pipe. By doing so, charge separation and charge displacement taking place using the directed gas flow of the heat pipe. This flow entrains one working medium of the gasdynamic electrostatic generator (i.e. charged dispersed liquid particles) and routes it onto one electrode past the other working medium of this generator, which other medium is electrically connected with an other electrode. As above mentioned external forces, i.e. the forces, which are exerted on the charges carrier working medium from the side of the energy source medium, here act the mechanical forces from the side of a heat pipe gas flow.

In the Figure 1 an embodiment variant of this method in a fixed device with its indicated orientation in the gravitational field is presented.

The solid working medium 6 and the liquid working medium 7 of the generator 2 are accommodated within the heat pipe, roughly at the location of the maximum flow of the working gas of the heat pipe 4, directly behind the diaphragm 13. The diaphragm 13 concentrates the gas flow from the vaporizer into the condenser. In doing to the solid working medium 6 is attached stationary with respect to the heat pipe.

The liquid working medium 7 is supplied to the interior of the heat pipe via the feeder 14, charge separation and charge displacement taking place using the directed gas flow of the heat pipe, which flow entrains liquid particles and routes them past the other working medium for charge separation and displacement.

Subsequently the charge is picked up on the external electrode 9a, quite analogously to the manner in which this takes place in all of electrostatic generators, inclusively generators with solid working media.

In one other embodiment variant (Figure 2) the loop 10 for return of the liquid working medium 7 of the generator is filled with the capillary structure. This makes it possible for the device to work regardless of its location in the gravitational field, and also in weightlessness. Here the open surface of the aforementioned capillary structure is housed directly behind the grid of the pick-up electrode 8.

In the embodiments of other possible versions of the process (Figure 3) charge separation takes place by the liquid 7 striking the medium 6. Here the medium 6 has the shape of for example a grid. In this case the solid working medium is moved at some distance from the insertion site of the feeder 14 into the interior of the heat pipe. The droplets of the medium 7 before striking the medium 6 acquire a certain kinetic energy which is expended for charge separation. After impact the charged droplets are carried on further with the gas flow of the heat pipe 4 to the electrode 8.

The gases which are not condensing and which remain in the heat pipe (for example air and also vapors of the working liquid of the generator which in a closed space are inevitably joined to the liquid which has a free surface) are pushed away by the working gas of the heat

pipe to one of the ends of the pipe in the first seconds of operation of the heat pipe, and form a gas cushion 15.

In the geometry of the heat pipe and the electrode for the charge pick-up 8 (Figures 1-3) this gas cushion to a certain extent thermally insulates the pick-up electrode 8 and the wall of the heat pipe adjoining it. Therefore the temperature of the electrode generally differs from the temperature of the capillary structure of the condenser of the heat pipe.

Since the insertion site of the feeder 14 into the heat pipe is outside of the vaporizer, the same liquid can be used as the working liquid of the heat pipe and of the generator.

Thermal energy is brought to and abstracted from the heat pipe 1 in the usual manner, i.e. it is brought to the vaporizer 11 and is abstracted from its condenser 12. In the case of using solar energy as a source, it can be supplied to the vaporizer by any usual manner, i.e. directly, or through the beam collection systems (mirror, lens), or through the heating of the adjacent to the heat pipe's vaporizer medium or the working medium of the heat exchanger, linked to the vaporizer of the heat pipe. In case of using industrial heat wastes as the source of thermal energy, thermal energy can be supplied either directly, i.e. by placing the vaporizer into the hot medium and the condenser into the medium which has ambient temperature, or with help of heat exchangers. Hence the manner of supplying the energy can vary any usual for heat pipes way, and it is not essential for the realization of the claimed method.

It is significant that:

a) Electrostatic generation is attained by the method proposed already at small temperature differences between the heat source and the environment. This makes it possible to use this method for conversion of energy from sources with relatively low specific density of energy, such as solar energy or industrial heat wastes.
b) Energy conversion by indicated method can be executed both already by low and by middle as well as high temperature differences; hereby in all cases the energy losses through reverse heat exchange from converter's working medium to thermal energy source are minimized because of explosively quick take-up of the thermal energy and it's irreversible conversion into other types of it inside the converter. Due to the same reason the converter's output power E/t is maximised, because the time **t** by which the energy **E** is transformed by this converter is very small.

CLAIMS

Method for producing electrical energy, in which the charges between two working media are separated triboelectrically or electrostatically, the charges are moved away from one another by displacement of the working media under the action of external forces, here the external forces performing work against the Coulomb force; and the charges being guided onto electrodes, **wherein** the indicated process steps are carried out within the inside volume of a heat pipe, charge separation and charge displacement taking place using the directed gas flow of the heat pipe, which flow entrains one working medium and routes it past the other working medium for charge separation and displacement.

2. Method as claimed in claim 1, **wherein** heat pipe has a necked-down section in it's transport-zone, and one working medium encompasses liquid particles which are entrained in the gas flow inside ore in the immediate vicinity of this neck-down section.

3. Method as claimed in claim 1 or 2, **wherein** one of the working mediums comprises a grid through which the gas flow passes.

4. Method as claimed in one of claims 1 to 3, **wherein** the other working medium is located within the heat pipe roughly at the position of maximum flow velocity.

5. Method as claimed in one of claims 2 to 4, **wherein** the liquid is recovered to form the liquid particles.

6. Method as claimed in one of claims 1 to 5, **wherein** the same liquid is used for the working liquid of the heat pipe and of the generator.

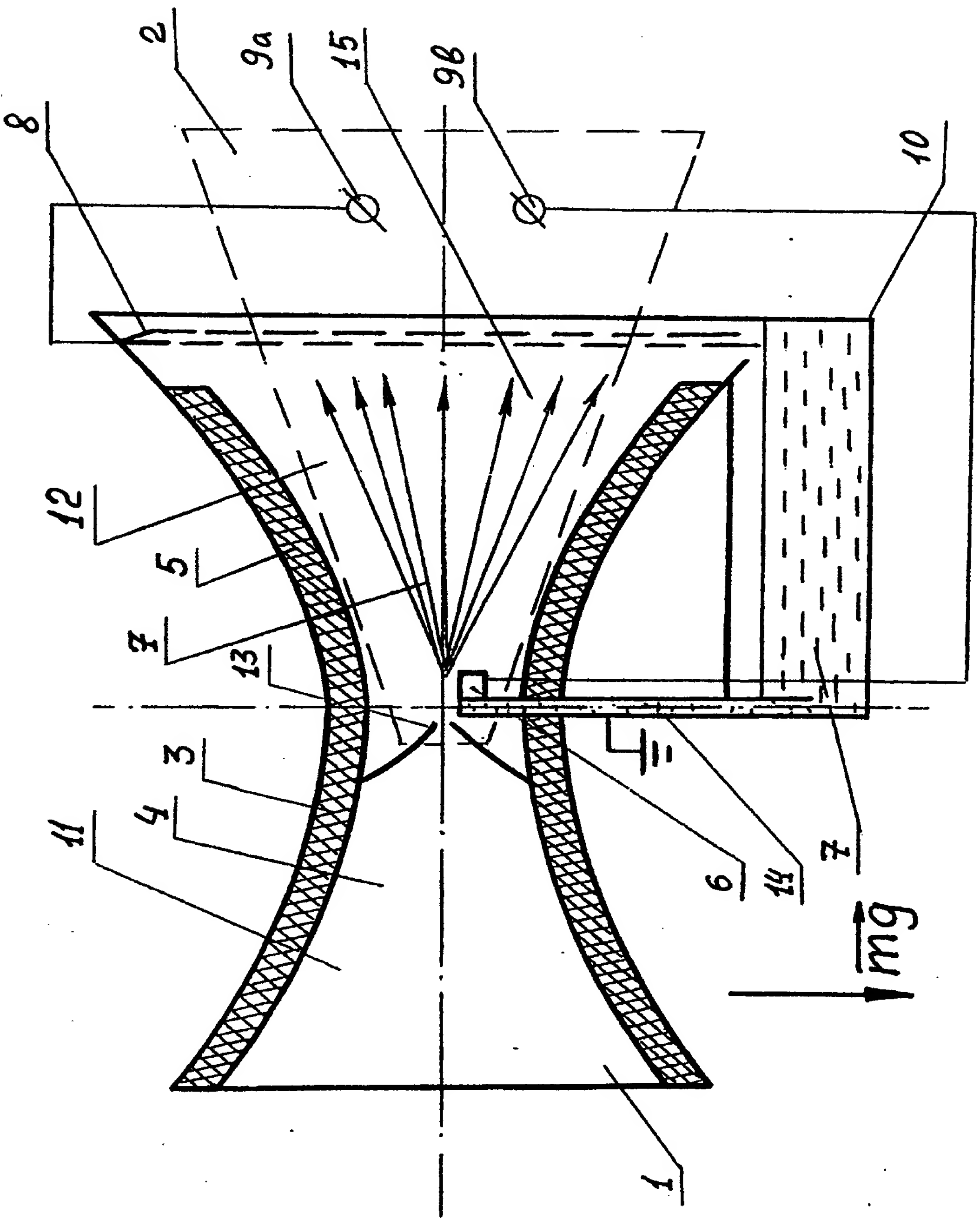

Fig. 1.

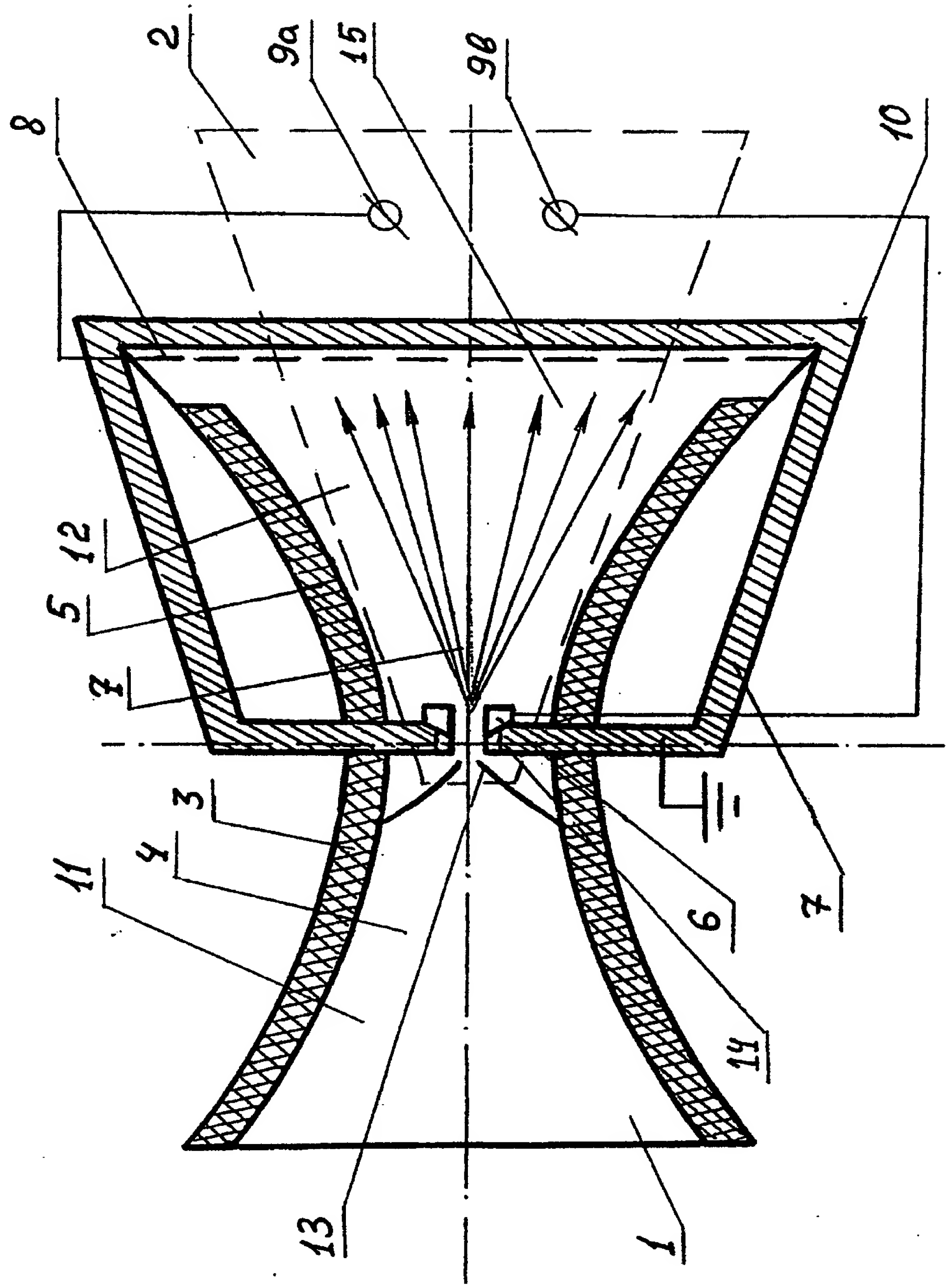

Fig. 2.

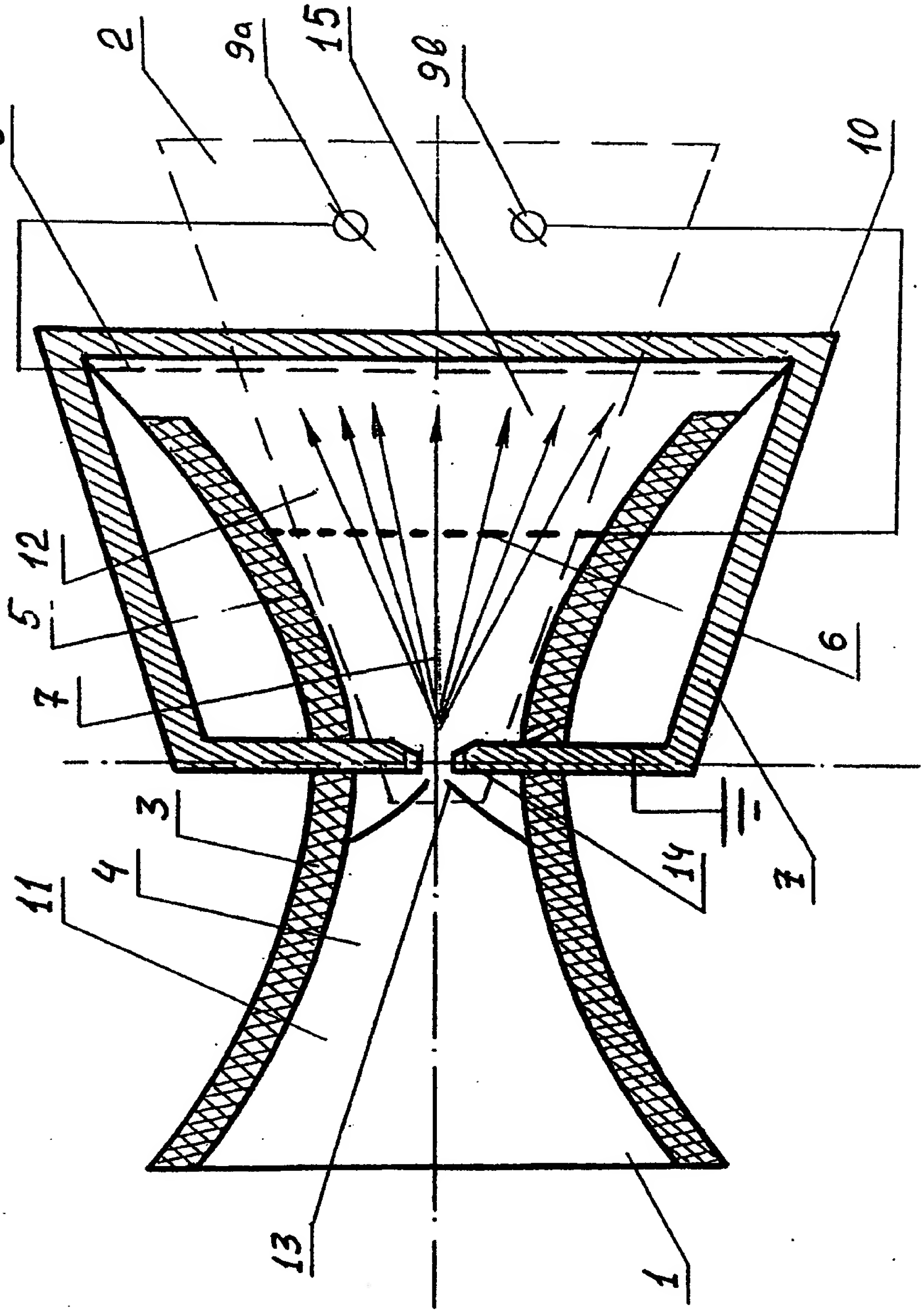

Fig. 3.